CLAIMS

1. Apparatus for processing sheet material comprising;

a set of rotatable rolls provided with one or more sheet-processing tools for engagement with the sheet material in the nip zone between the roll set;

a first drive for rotating the roll set;

a second drive upstream of the nip zone for effecting feed of the sheet material; and

means operable to co-ordinate operation of the second drive with rotation of the roll set in such a way that sheet feed through the nip zone is effected for part of the time by the roll set and for part of the time by the second drive, the second drive imparting feed to the sheet material through drive transmitting means which freewheel while in engagement with the roll driven sheet.

2. Apparatus for processing sheet material comprising;

a set of rotatable rolls provided with one or more sheet-processing tools for engagement with the sheet material in the nip zone between the roll set;

a first drive for rotating the roll set;

a second drive upstream of the nip zone for effecting feed of the sheet material; and

means operable to co-ordinate operation of the second drive with rotation of the roll set in such a way that sheet feed through the nip zone is effected for part of the time by the roll set and for part of the time by the second drive.

3. Apparatus as claimed in Claim 1 or 2 in which the feed of sheet material through the nip zone is effected by the roll set at least while there is tool-sheet engagement.

4. Apparatus as claimed in Claim 1, 2 or 3 in which feed of sheet material through the nip zone is effected by the second drive at least for part (preferably a major part) of the time that there is no tool-sheet engagement.

5. Apparatus as claimed in any one of Claims 1 to 4 in which the roll set is provided with two or more circumferentially spaced sheet-processing tools.

6. Apparatus as claimed in Claim 5 in which the roll set is provided with a traction section trailing one of the tools for imparting feed motion to the sheet material subsequent to disengagement between said one tool and the sheet.

7. Apparatus as claimed in any one of Claims 1 to 6 in which the second drive is a variable speed drive operable to vary the speed profile of sheet material feed through the nip zone.

8. Apparatus as claimed in Claim 1 or any one of Claims 3 to 7 when dependent on Claim 7 including means for braking or damping freewheeling of said drive transmitting means so that freewheeling is arrested substantially immediately upon disengagement of the sheet from the drive transmitting means.

9. Apparatus as claimed in Claim 1 or 8 in which the drive transmitting means comprises rollers which engage the sheet material.

10. Apparatus as claimed in Claim 1 or 8 in which the drive transmitting means includes one or more endless conveyor belts which engage the sheet material.

11. Apparatus as claimed in any one of Claims 1, 8, 9 and 10 in which, during roll driven sheet material feed, the second drive is arrested or operates at a reduced drive speed compared with the roll drive speed.

12. Apparatus as claimed in any one of Claims 1 and 8 to 10 in which, during roll driven sheet material feed, the second drive is arrested or operates at a reduced drive speed compared with the roll drive speed and in which said drive transmitting means operates automatically in freewheel mode when engaged with sheet material being fed at a speed exceeding that of the second drive.

13. Apparatus as claimed in any one of Claims 1 to 12 in which, immediately prior to transfer of sheet material feed from the second drive to the roll set or *vice versa*, the second drive is programmed to run at a speed which is reduced compared with the roll speed.

14. Apparatus as claimed in any one of Claims 1 to 12 in which, during the interval leading up to transfer of sheet material feed from the second drive to the roll set or *vice versa*, the second drive operates in a mode in which its speed exceeds the roll speed and is then adjusted to a lower speed.

15. Apparatus as claimed in Claim 14 in which said lower speed is less than the roll speed.

16. Apparatus as claimed in any one of Claims 1 to 15 in which the co-ordinating means is programmable in dependence upon the configuration of tool operations to be performed on the sheet.

17. Apparatus as claimed in any one of Claims 1 to 16 in which the sheet material is fed to the roll set as discrete blanks.

18. Apparatus as claimed in any one of Claims 1 to 16 in which the sheet material is fed to the roll set as a continuous web of material.

19. Apparatus for feeding sheet material sequentially on demand to take up mechanism of sheet processing machinery, said apparatus comprising a feed table having a gate and upon which the sheets may be stacked against the gate which allows only the lowermost sheet to pass therebeneath, a bed of rollers within the surface of the table which may be rotatably driven to advance the lowermost sheet beneath the gate to the take-up mechanism, means to allow the rollers to free-wheel once the lowermost sheet is being advanced thereover by said take-up mechanism, and means for restraining freewheeling roller feed of the next lowermost sheet after the sheet being fed has passed under the gate.

20. Apparatus for feeding sheet material sequentially on demand to take up mechanism of sheet processing machinery, said apparatus comprising a feed table having a gate and upon which the sheets may be stacked against the gate which allows only the lowermost sheet to pass therebeneath, a bed of rollers within the surface of the table which may be rotatably driven to advance the lowermost sheet beneath the gate to the take-up mechanism, means to allow the rollers to free-wheel once the lowermost sheet is being advanced thereover by said take-up mechanism, and means for restraining freewheeling roller feed of the next lowermost sheet after the sheet being fed has cleared the rollers.

21. Apparatus for feeding sheet material sequentially on demand to take up mechanism of sheet processing machinery, said apparatus comprising a feed

surface having a gate and upon which the sheets may be stacked against the gate which allows only the lowermost sheet to pass therebeneath, conveyor means associated with the feed surface for advancing the lowermost sheet beneath the gate to the take-up mechanism, means to allow the conveyor means to free-wheel once the lowermost sheet is being advanced thereover by said take-up mechanism, and means for restraining freewheeling feed of the next lowermost sheet after the sheet being fed has cleared the conveyor means.

22. Apparatus as claimed in Claim 21 in which the conveyor means comprises roller means which directly engage with the lowermost sheet.

23. Apparatus as claimed in Claim 21 in which the conveyor means comprises roller means which contact the lowermost sheet indirectly through one or more conveyor belts entrained around the roller means.

24. Apparatus as claimed in any one of Claims 19 to 23 in which the restraining means comprises brake means acting on the rollers or conveyor means.

25. Apparatus as claimed in any one of Claims 19 to 23 in which the restraining means comprises vacuum suction means located upstream of the rollers or conveyor means to hold the next lowermost sheet against the action of the freewheeling rollers after the sheet being fed has passed under the gate.

26. Apparatus according to any one of Claims 19 to 25 in which the take-up mechanism comprises a tool-carrying roll set.

27. Apparatus according to any one of Claims 19 to 26 in which the rollers or conveyor means are fitted with sprag clutches and advance the sheet being fed at

substantially the same speed as, or a slower speed than that of, the take-up mechanism.

28. Apparatus according to any one of Claims 19 to 28 in which the rollers or conveyor means are driven by a servo electric motor which alternately drives the rollers or conveyor means forwardly and stops, the timing of the motor being controlled by the processing machinery.

29. Apparatus according to any one of Claims 19 to 28 wherein vacuum suction is applied from beneath the rollers or conveyor means to pull the lowermost sheet downwardly against the rollers.

30. Apparatus according to Claim 19 or 20 wherein the rollers are rotatably interconnected by timing drive belt means, one of which rollers is driven by a further timing drive belt.

31. Apparatus according to Claim 30 wherein said further drive belt is toothed.

32. Apparatus for feeding sheet material sequentially on demand to take-up mechanism of sheet processing machinery, said apparatus comprising a feed table having a gate and upon which sheets may be stacked against the gate which allows only the lowermost sheet to pass therebeneath, drive transmitting means driven by a servo-motor to advance the lowermost sheet beneath the gate to the take-up mechanism, a sensing means between the gate and the take-up mechanism to detect the passage of a datum position of the sheet, a microprocessor which receives data indicating the position of the take-up mechanism and from the sensing means and programmed to control the servo-motor to ensure that the sheet presents itself to the take-up mechanism at the correct instant.

33. Apparatus for feeding sheet material sequentially on demand to take-up mechanism of sheet processing machinery, said apparatus comprising a servo-drive motor, means for transmitting drive from the servo-drive motor to the sheet material to advance the sheet material to the take-up mechanism, sensing means for detecting the passage of a datum position of the sheet material as the latter advances towards the take-up mechanism, and a microprocessor which receives data indicating the position of the take-up mechanism and from the sensing means and programmed to control the servo-drive motor to secure registration between the sheet material and the take-up mechanism, the drive transmitting means being operable automatically in a freewheel mode while in engagement with sheet material travelling at a speed greater than the speed of the servo-drive motor.

34. Apparatus according to claim 32 or 33 wherein the microprocessor is programmed to ensure that the leading edge of the sheet presents itself to the take-up mechanism at a desired speed.

35. Apparatus according to claim 34wherein the desired speed is slightly less than the speed at which the take-up mechanism forwards the sheet.

36. Apparatus according to claim 34wherein the desired speed is zero.

37. Apparatus according to any one of Claims 32 to 36 wherein the take-up mechanism comprises a pair of take-up rolls.

38. Apparatus according to any one of Claims 32 to 36 wherein the take-up mechanism comprises gripper bars.

39. Apparatus according to any one of Claims 1, 8 to 10 and 32 to 38 wherein the means driven by the second drive or the servo-motor comprises a bed of rollers within the surface of the table which are rotatably driven to advance the lowermost sheet beneath the gate to the take-up mechanism when forward drive to the rollers is arrested and means to allow the rollers to free-wheel once the lowermost sheet is being advanced thereover by the roll set or take-up mechanism.

40. A method of treating sheet material by passage through the nip between a set of rotatable rolls provided with a least one sheet treatment tool, comprising: driving the sheet material through the nip for part of the time by means of the rolls and for part of the time by a separate servo-controlled drive which acts on the sheet material at a location upstream of the nip, the servo-controlled drive being transmitted to the sheet through roller means or conveyor belt means capable of freewheeling while in contact with the roll set-driven sheet material.

41. A method of treating sheet material by passage through the nip between a set of rotatable rolls provided with a least one sheet treatment tool, comprising: driving the sheet material through the nip for part of the time by means of the rolls and for part of the time by a separate servo-controlled drive which acts on the sheet material at a location upstream of the nip.

42. A method as claimed in Claim 40 or 41 including supplying the sheet material to the nip in the form of discrete sheets.

43. A method as claimed in Claim 40 or 41 including supplying the sheet material to the nip in the form of a continuous web.

44. A method as claimed in Claim 43 in which the continuous web is severed into discrete sheets by the rolls.

45. A method as claimed in Claim 42 or 44 in which the length of the discrete sheets exceeds the circumference of the tool-carrying roll.

46. A method as claimed in any one of Claims 40 to 45 in which, between successive tool-sheet operations on a given sheet or section of sheet material, the servo-controlled drive feeds a section of sheet through the nip of a length which differs from the circumferential spacing on the roll between the tool(s) effecting such operations.

47. A method as claimed in Claim 40 or any one of Claims 42 to 46 when dependent on Claim 40 including applying a braking force to the freewheeling roller means or conveyor belt means to prevent over run thereof.

48. A method as claimed in any one of Claims 40 to 47 including sensing the sheet position by detection of a datum position on the sheet and controlling sheet feed by the servo-controlled drive to secure at least initial registration between the sheet and the roll set tooling.

49. A method as claimed in any one of Claims 40 to 47 including sensing the sheet position by detection of a plurality of lengthwise spaced datum positions on the sheet and controlling sheet feed by the servo-controlled drive to secure and maintain registration between the sheet and the roll set tooling.

50. A method as claimed in any one of Claims 40 to 49 including feeding a terminal trailing section of the sheet through the nip by means of a non-tool-carrying section of the roll set.

51. Sheet treated by the method claimed in any one of Claims 40 to 50.